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A new species of *Callochiton* (Mollusca: Polyplacophora)
from the Strait of Messina (central Mediterranean)

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Abstract

A new species of *Callochiton*, *C. XXXXXXXXX* n. sp., has been identified in the framework of investigations aimed to better characterize the Strait of Messina benthic ecosystem. The new species, exclusively found in a peculiar facies of hard bottoms densely colonized by the hydrocoral *Errina aspera* (Linnaeus, 1767), is morphological distinct from the co-generic *Callochiton septemvalvis* (Montagu, 1803), living in European seas, and *C. doriae* (Capellini, 1859), living in the Mediterranean Sea.

Key words: Mollusca, Polyplacophora, *Callochiton*, Recent, Strait of Messina, new species.

INTRODUCTION

Three species of *Callochiton* Gray, 1847 are known from the Atlantic coasts of Europe and the Mediterranean Sea. *Callochiton calcatus* Dell'Angelo & Palazzi, 1994 is a rare species restricted to the Mediterranean. The other two species, *C. septemvalvis* (Montagu, 1803), living in European seas, and *C. doriae* (Capellini, 1859), living in the Mediterranean Sea, are very similar to each other, differing mainly by the absence or presence of longitudinal grooves on the pleural areas of the intermediate valves and antemucronal area of the tail valve. There was previously some room for doubt about whether these two morphotypes represented distinct species, or rather the morphological plasticity of *C. septemvalvis* (e.g. THIELE 1902; BERGENHAYN 1931; LELOUP 1934; KAAS 1978; CARMONA ZALVIDE et al. 2002). Individuals attributed to both these species of *Callochiton* were included in a molecular phylogeny published by SIGWART et al. (2013) with one specimen of *C. septemvalvis* from France (Roscoff, Atlantic Ocean) and one of *C. "euplaeae"* (O.G. Costa, 1830) (not 1829 as usually indicated, see FASULO 2013) from Croatia (Adriatic Sea). However, the taxon *Callochiton euplaeae* is a *nomen dubium*, as reported by DELL'ANGELO et al. (2016). To clarify, considering the more appropriate available name *C. doriae*, the Mediterranean members of the species of *Callochiton* without longitudinal grooves on the pleural areas should be attributed to *Callochiton septemvalvis*, whilst the species with longitudinal grooves is *Callochiton doriae*.

In this paper, we describe some small specimens of *Callochiton* sampled in the framework of research cruises carried out in a peculiar habitat of the Strait of Messina. These specimens lack longitudinal grooves (the key character for separating *C. septemvalvis* and *C. doriae*), yet differ from other congeners, and they are therefore described as a new species, *C. XXXXXXXX* n. sp.

The Strait of Messina (Fig. 1) is characterized by strong tidal currents which create a constant upwelling regime. Such peculiar hydrology makes the area distinct from the major Mediterranean sectors, it is noted as hosting "a wealth of biogeographic peculiarities, including Pliocene Atlantic remnants and local endemisms" (BIANCHI et al. 2012), and recent studies of the region have frequently described new species (BOGI & CAMPANI 2006, 2007; BUZZURRO & RUSSO 2007; BOGI & BARTOLINI 2008; CROCETTA et al. 2009; TISSELLI et al. 2009; BOGI et al. 2016; RENDA & MICALI 2016; SMRIGLIO et al. 2016), all of which combine to make the Strait an apparent biodiversity hotspot. One of the most peculiar environments of the Messina Strait is probably the "Sill", a rough seafloor that connects the Calabrian and Sicilian continental slope, where it extends southernmost throughout Rada Paradiso (GIACOBBE et al. 2007). Such steep hard bottoms are densely colonized by the hydrocoral *Errina aspera* (Linnaeus, 1767), representing an exclusive facies from the

subtidal-bathyal transition (DI GERONIMO & FREDJ 1987).

MATERIALS AND METHODS

From the “Sill” in the Strait of Messina, twenty small sized specimens of *Callochiton* sp. were sampled in the framework of two distinct cruises (Errina’87 and POP’95) sponsored by the University of Messina (Table 1), aimed to better define the distribution of the hydrocoral-dominated biotope (GIACOBBE 2001; GIACOBBE et al. 2007) and to investigate the major associated species (GIACOBBE & RINELLI 1991; GIACOBBE & SPANÒ 2001). The *Callochiton* specimens were also compared with other material collected by fishing boats at different times from the same area.

Morphological features and diagnostic characters of the chiton specimens were studied and detected by scanning electron microscope (SEM) at the Messina University. The digital images were obtained using a Motic SMZ-140 Microscope with the software Motic Images Plus.

The following abbreviations are used:

BD	B. DELL’ANGELO Collection, Genova, Italy (will be deposited in MZB)
BEL	Benthic Ecology Laboratory, Department of Chemical, Biological, Pharmaceutical and Environmental Sciences, University of Messina, Italy
MS	M. SOSSO Collection, Genova, Italy
MZB	Museo di Zoologia dell’Università di Bologna, Bologna, Italy
POP	Programma Operativo Plurifondo, Sicilia 1994-99
SMF	Senckenberg Forschungsinstitut und Naturmuseum, Frankfurt a. Main, Germany;
spm	specimen
WR	W. RENDA Collection, Amantea (CS), Italy

SYSTEMATICS

Class Polyplacophora Gray, 1821

Order Chitonida Thiele, 1909

Family Callochitonidae Plate, 1901

Genus *Callochiton* Gray, 1847

Type species. *Chiton laevis* Montagu, 1803 (*non* Pennant, 1777) [= *Callochiton septemvalvis* (Montagu, 1803), *fide* KAAS 1978] by subsequent designation (GRAY 1847).

Distribution. Tropical and subtropical regions of the Indo-Pacific (including Japan; absent from the northeastern Pacific). In the Atlantic Ocean restricted to the eastern part and to sub-Antarctic and Antarctic part (KAAS & VAN BELLE 1985). Neogene – Recent.

***Callochiton* XXXXXXXX n. sp.**

Figures 2–4

Type material. Holotype: MZB 32137, spm disarticulated and coated for SEM analysis, length 4.3 mm (Figs 3A–N). Paratype: BEL 117 POP'95 DG11, length 2 mm.

Material examined. The type material and 18 specimens were collected from the sites reported in Table 1. An additional six specimens are in the BD collection from separate collected events, all from fishing boats working in the Strait in environments colonized by *Errina aspera*, and probably coming from the Sill in the Strait of Messina. All the material examined is reported in Table 2.

Type locality. Strait of Messina, Rada Paradiso, dredging station DG11 (Table 1, Figure 1).

Etymology. The species is named after Stefania Minerva, the last author's wife and herself a marine biologist.

Diagnosis. Animal of small size, ovate, moderately elevated, tegmentum and girdle uniformly coloured from very light brownish to rosaceous. Tail valve semicircular, with a small, hardly raised mucro in anterior position, antemucronal and postmucronal slopes straight. Tegmentum surface appears rough, sculptured with fine, tabulate elongate granules, well separated on the lateral areas and fusing into continuous lines in the central areas. Slit formula 17/2/14. Girdle wide, densely covered with fine, smooth, dorsal imbricating spicules, a marginal fringe of lanceolate spicules, and ventral small, flat spicules. Radula with 30 transverse rows of mature teeth, major lateral tooth with a tridentate cusp, the denticles of almost equal length.

Description. Animal of small size, 4.3 mm in length, ovate, moderately elevated, girdle rather wide, tegmentum and girdle uniformly coloured from very light brownish to rosaceous.

Head valve semicircular with almost straight anterior slope, posterior margin widely V-shaped, without central posterior notch. Intermediate valves rectangular, subcarinate with the top rounded, dorsal elevation 0.36 (valve IV; fig. 3I), anterior margin almost straight, side margins rounded, posterior margin slightly concave at both sides of the well pronounced apex, lateral areas moderately raised. Tail valve semicircular, anterior margin slightly convex, with a small, hardly raised mucro in anterior position, antemucronal and postmucronal slopes straight.

Tegmentum surface appears rough, sculptured with fine, tabulate elongate granules, well separated on the lateral areas and fusing into continuous lines in the central areas (Figs 3H, 4D). Overall appearance of valves is finely striated when examined under magnification, striae longitudinally oriented in central and antemucronal areas, radially oriented in head valve, lateral areas and postmucronal area, marked with a few concentric growth lines toward the outer margins.

Articulamentum rose coloured in the centre, whitish towards the sides, apophyses wide, short, regularly rounded, connected at the jugum by a lamina, insertion plates short, slit formula 17/2/14, teeth irregular, slit rays scarcely visible, eaves very porous, apical area of head and intermediate valves marked by longitudinal fine furrows (Figs 3L–M).

Girdle wide, densely covered with fine, straight, smooth, imbricating spicules, closely tightened to the surface, directed inward, ca. 75-95 x 21-25 µm (in situ), oval in diameter. Some slender, smooth, curved spines, 230-260 µm long (measured in spm MZB 32138 in situ) are found close to the outer margin (Figs 4J–K). There is a marginal fringe of lanceolate, feather-like striated, somewhat flattened spicules, ca. 87-97 µm long and 22-24 µm wide. Ventral side covered with transverse rows of small, bluntly pointed, flat spicules, ca. 50 µm long (measured in spm MZB 32138 in situ).

Radula with 30 transverse rows of mature teeth, asymmetric, central tooth with a narrow blade, first lateral teeth distally widening, major lateral tooth with a tridentate cusp, the denticles of almost equal length.

Remarks. No trace of grooves was found in the central areas of any of the listed specimens examined from the Strait of Messina, contrary to what observed on other specimens of *Callochiton* collected along the coasts of Calabria and Sicily of the Strait and attributed to *Callochiton doriae*, which always have conspicuous longitudinal grooves, even as juveniles (MONTEROSATO 1879; GIOVINE & DELL'ANGELO 1993).

The valves of the specimen disarticulated for SEM analysis (Figs 3G–N) are quite eroded and some features (especially in the articulamentum) are not clear, so we present additional images of valves (Figs 4A–I) from another specimen from DG04 (broken in half and therefore not counted in the material examined) with the valves better preserved. The girdle of this specimen also includes some irregularly spaced much longer needles dorsal to the marginal fringe in the form of ringshaft-needles (ca 260 µm long; Fig 4J–K).

Callochiton XXXXXXXX n. sp. differs from *C. doriae* and *C. septemvalvis* by the following features:

- (a) the smaller size, up to 24 mm in length for *C. doriae* (DELL'ANGELO & PALAZZI 1994) and

22 mm for *C. septemvalvis* (CARMONA ZALVIDE et al. 2002), vs. up to 4.6 mm for *C. XXXXXXXX*;

(b) the uniform very light brownish to rosaceous colour, both for the tegmentum and for the girdle, vs. a variable colour in *C. doriae* / *C. septemvalvis*, which are more or less variegated with spots of various colours, and often with lighter colored bands on the girdle (KAAS & VAN BELLE 1985; DELL'ANGELO & SMRIGLIO 1999);

(c) the shape of tail valve, with the mucro central in *C. doriae* / *C. septemvalvis* (e.g. KAAS & VAN BELLE 1985: fig. 2.8-9; DELL'ANGELO & SMRIGLIO 1999: pl. 40, fig. G, pl. 41 fig. J), in anterior position in *C. XXXXXXXX* (Figs 3J–K);

(d) the different size of dorsal girdle spicules, 150-280 x 25-32 μm in *C. septemvalvis* / *C. doriae* (KAAS & VAN BELLE 1985) vs. 75-90 x 21-25 μm in *C. XXXXXXXX*. CARMONA ZALVIDE et al. (2002) give 130-190 x 50-60 μm for *C. doriae*, 100-200 x 50-100 μm for *C. septemvalvis*.

(e) the lack of longitudinal grooves on the central areas, always evident in *C. doriae* including in juvenile specimens. We include SEM photos of two juvenile specimens of *C. doriae*, for comparison (Figs 5A–C).

Callochiton XXXXXXXX n. sp. differs from *C. calcatus* by the shape of the valves, strongly angulated and elevated in *C. calcatus* (dorsal elevation 0.65–0.72 vs. 0.36 in *C. XXXXXXXX* n. sp.), the postmucronal slope of tail valve, convex and very characteristic in *C. calcatus* (see DELL'ANGELO & SMRIGLIO 1999: p. 133, fig. 7B), the intermediate valves trapezoidal in *C. calcatus*, and moreover the lack of longitudinal grooves on the central areas in *C. XXXXXXXX* n. sp., well evidenced in *C. calcatus*.

Species in the genus *Callochiton* possess pigmented aesthetes (BAXTER & JONES 1984; SCHWABE 2010). Only a subset of the shell pores associated with the aesthete system found in *Callochiton* spp. contain pigments. The pigmented aesthetes in *Callochiton* spp. are regularly arranged over the shell lateral areas and in radial rows in the head and postmucronal area of the tail valve (BAXTER & JONES 1984), and are surprisingly difficult to see, the visibility depending on the direction on view too. We were not able to confirm the presence of pigmented aesthetes in *C. XXXXXXXX* but we also cannot confirm their absence. The lacking of visible pigments in aesthetes has been already reported in literature (e.g. DELL'ANGELO et al. 2012 for *Callochiton cupreus* Dell'Angelo, Prella, Sosso & Bonfitto, 2012 from Madagascar).

The longitudinal fine furrows present in the apical area of head and intermediate valves (Fig. 3L–M) seem of particular interest. The apical areas of *Callochiton septemvalvis* / *C. doriae* are smooth, which has not been previously noted but is apparent from published SEM images of those species (BAXTER & JONES 1984: pl. 4, figs (a), (c); DELL'ANGELO & SMRIGLIO 1999: pl. 40, figs D, F). Likewise, these fine furrows are not visible in the other Mediterranean *Callochiton* species, *C.*

calcatus. Any functional significance of the peculiar furrows is unclear, and awaits further studies.

With this material, as for many chitons so far, there are very few data available for molecular genetic comparisons. With regard to *Callochiton septemvalvis* / *C. doriae*, to our knowledge only two specimens have been sequenced for *C. septemvalvis* (OKUSU et al. 2003, SIGWART et al. 2013), and 1 specimen for *C. doriae* (SIGWART et al. 2013). We have established here the distinctive morphologies of *Callochiton septemvalvis* / *C. doriae*, but we note that there may be more hidden diversity within the Atlantic and Mediterranean members of *Callochiton*.

The habitat of *C. XXXXXXXX* is different from those known for *C. doriae* / *C. septemvalvis*, which are known from shallow water (20-30 cm) to a maximum of 580 m (KAAS & VAN BELLE 1985; KAAS 1991), preferentially living on coralline algae. The habitat of *C. XXXXXXXX* is inferred from our limited data to be very restricted; to date, the species has been collected only in the “rough bottoms” of the Strait. The other records, occasionally collected from fishing boats, cannot be verified but plausibly came from the same area and environment. In the “rough bottoms”, dense colonies of the hydrocoral *Errina aspera*, cover all the hard substrates from almost 90 m to 200 m depth, forming an exclusive facies in association with the giant barnacle *Pachylasma giganteum* (Philippi, 1836) (DI GERONIMO & FREDJ 1987). Such facies are characterized by highly diversified communities that include a mixture of Atlantic subtropical (GIACOBBE & SPANÒ 2001) and temperate (GIACOBBE & RINELLI 1991) taxa; nevertheless, the *E. aspera* colonies are relatively sparsely covered in epibiota, except for the snail predators specifically associated with *Pedicularia sicula*, preying upon the hydrocoral polyps, and occasional epibionts such as the barnacle *Megatrema anglicum* (Sowerby, 1823) (DINATALE & MANGANO 1985). The specimens of *C. XXXXXXXX*, although exclusively recorded in *E. aspera* samples, were always found detached. Nevertheless, their small size together with the peculiar shell roughness and pale rosaceous color, similar with the *E. aspera* skeleton, suggest a possible association with the hydrocoral bioconstruction.

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